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GROWTH OF AVOCADO SEEDLINGS AS AFFECTED BY THE RATE OF SOIL DRAINAGE

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The control of soil moisture is frequently interfered with by one or more factors such as silt or clay deposits of varying thickness and continuity, abrupt or marked changes in the pore space at various soil depths, hardpans, excessive rainfall, and an impaired state of health in the rootlets that reduces their absorption of water. When leaves become chlorotic (yellow with the veins remaining green) they utilize less soil moisture and their condition becomes steadily worse unless the amount of irrigation water applied is reduced.

When irrigation water is applied to the soil, it wets to the field capacity all of the soil through which it passes. Prolonged retardation in the movement of soil moisture serves to unduly delay the introduction of air (containing oxygen) into the excessively wet area. It is important to know whether or not a soil will drain below a certain depth and at what rate the drainage occurs, for otherwise the excess of soil moisture may be moving so slowly as to interfere with the aeration of the rootlets. Avocado rootlets require considerable oxygen and the rate of the downward movement of the soil moisture containing oxygen in avocado orchards may determine whether plantings shall thrive or become increasingly injured and the roots become susceptible to fungous attack.

Drainage facilitates the removal of residual or unused salts and draws air (containing oxygen) into the soil in addition to the dissolved oxygen that occurs in the applied irrigation water. Even though soil drainage is essential, it may, when it is too rapid, deprive the roots of a favorable soil moisture condition.

Avocado trees grow well in artificial solution cultures or in soil adequately watered, provided that a sufficient supply of oxygen is available. An avocado tree, vigorously growing in a container (about 20 inches in diameter by 26 inches high) filled with culture solution, nearly reached the top of the glasshouse. An interruption of several hours in the aeration of the culture solution was followed by an appreciable drooping of the new shoots which never quite regained their original position once the aeration of the culture solution was resumed. An inspection showed that the white new roots had darkened appreciably during the oxygen starvation period.

When the excess of soil moisture fails to move sufficiently rapidly before its dissolved oxygen is exhausted, injury and infection of the rootlets may follow. In the better drained soils of many avocado orchards there may occur only a temporary retardation in the downward movement of the soil moisture. This may initially favor certain growth processes, but if too prolonged, will cause injury, the degree of which will depend upon the extent and duration of the drainage interference.

In the present experiment, use was made of avocado seedlings growing in cultures the soil of which drained very satisfactorily in the field. The soil drainage in the cultures was artificially interfered with by regulating the size of the drainage outlets, and then noting the effects upon the growth of the seedlings.

EXPERIMENTAL

A series of ten large pails (15 inches in diameter at the top, 10 inches in diameter at the base and 10 inches high) were nearly filled with Hanford loam soil placed on a small amount of pea gravel that covered the glass wool over the drainage outlet. Three holes (each five-eighths inches in diameter) had been drilled through the bottom of each pail. In the first pail drainage was prevented by placing a stopper in each hole. In the second pail, two of the holes were closed whereas the third hole contained a cork through which passed a glass tube with an inside diameter opening of one-sixteenths inches. The next five pails were similar to the second pail except that the glass tube outlets had the following inside diameter openings: two, three, four, six, and eight-sixteenths inches respectively. The eighth pail had only one of the five-eighths inches diameter holes fully open; the ninth had two open; whereas the tenth had all three open. Thus in these soil cultures the drainage of any excess soil moisture was interfered with to various degrees by changes in the size of the water-escape outlets.

A group of Nabal avocado seed was selected for uniformity of size and shape. They were soaked for several hours to soften and remove the seed coat, after which they were germinated in moist plaster sand maintained at 75° to 80° F. in an uncovered propagation frame. On August 26, 1947, when the tops were 2 to 3 inches high, a seedling was planted in each of the ten soil cultures.

The Hoagland's nutrient solution used contained (in terms of parts per million of solution) the following concentrations of the various constituents; calcium 159, magnesium 54, potassium 185, sodium 7, chlorine 10, sulfate 216, nitrate 718, and phosphate 105. The solution had a pH of 4.4 when made up with distilled water and was added in similar large amounts to each soil culture from time to time whereas distilled water alone was added when required. The culture without drainage was cared for in a manner as to obtain the best growth possible under the conditions at hand without accumulating too large an excess of water in the bottom of the culture. In the other cultures any excess of soil moisture was allowed to escape at a rate governed by the diameter of the drainage outlets. The plants were grown in the glasshouse until November 8, 1948 when they were harvested.

RESULTS

The heights of the trunks were measured when the experiment was concluded and the results are plotted in figure 1. The shortest trunk occurred in the culture that had no drainage outlet. As the size of the drainage outlets was increased, the trunks became longer until the outlets were too large in which cases the soil failed to retain sufficient soil moisture for the best plant growth. Too rapid as well as too slow a drainage of the excess of soil moisture resulted in a retardation of the growth of the trunk. The trunks

were weighed and as shown in figure 2, the results closely resemble those of figure 1.

The data for the total fresh weight of each plant (leaves, trunk, and root) are plotted in figure 3. Again some retardation of drainage was beneficial and growth was best when the drainage rate was neither too slow nor too rapid.

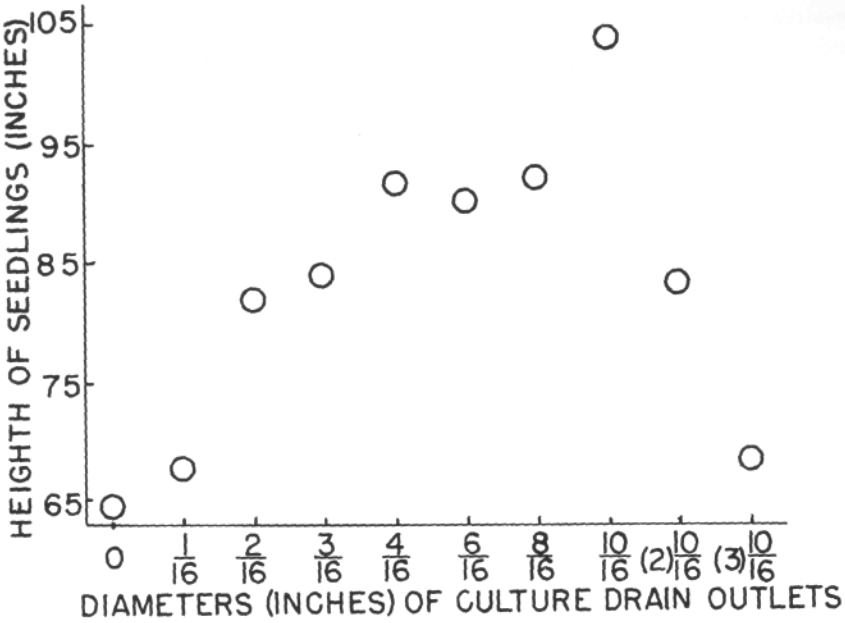

Fig. 1. *Relation of the heights of avocado seedlings to the size of the drainage outlets. The best growth occurred where the drainage was neither too slow nor too rapid.*

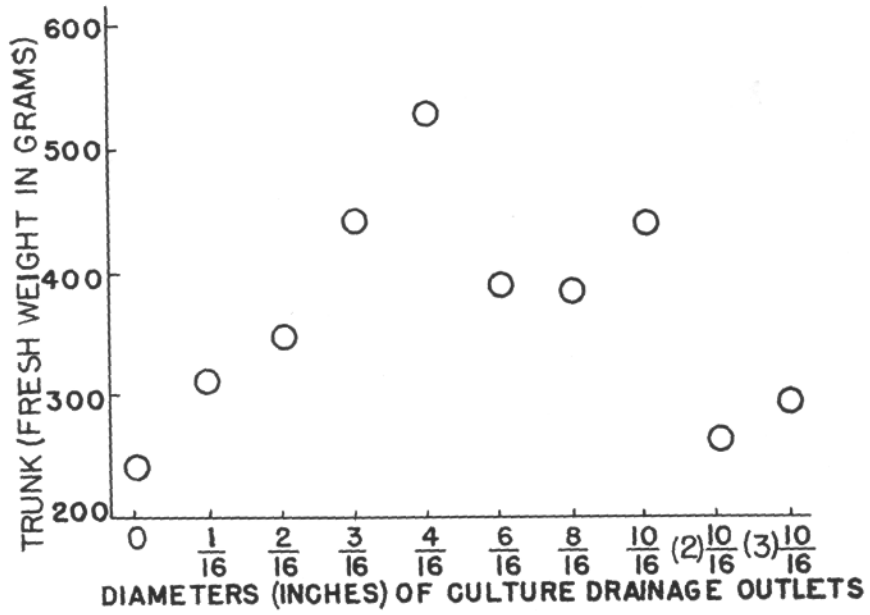

Fig. 2. *The same relation shown for the trunk heights in fig. 1 was obtained when the fresh weights of the trunks were plotted against the size of the drainage outlets.*

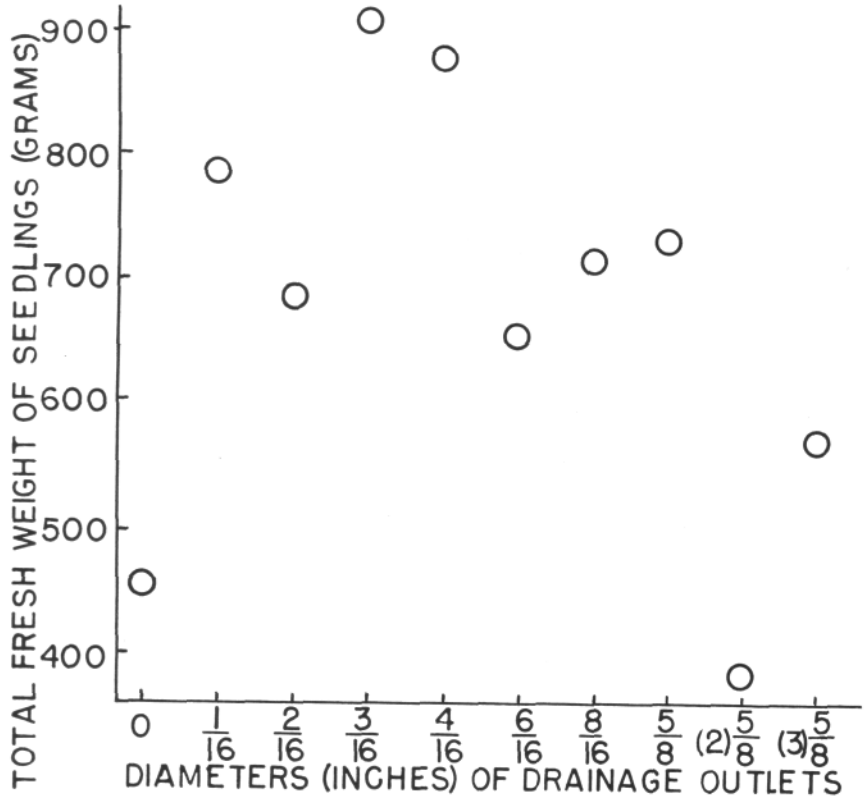

Fig. 3. *The total fresh weights of avocado seedlings (leaves, trunk, and root) in relation to the size of the drainage outlets: reduced growth occurred when the drainage rate was too slow or too rapid.*

The effect of the rate of drainage on the growth of the roots alone may be of interest. The fresh weights of the roots were plotted in relation to the size of the drainage outlets (fig. 4). As the rate of drainage decreased the fresh weight of the roots increased except that where no drainage at all occurred, the fresh weight of the roots was lowest of all.

SUMMARY

With a soil that drained without much difficulty, a study was made of the effect of reducing the rate of drainage of excess soil moisture upon the growth of avocado seedlings. The total fresh weights (leaves, trunk, and root) of avocado seedlings and the heights or fresh weights of the trunk were greatest when the rate of drainage was neither too slow nor too rapid. The fresh weights of the roots increased as the rate of drainage decreased except that where no drainage occurred the fresh weight of the roots was the lowest.

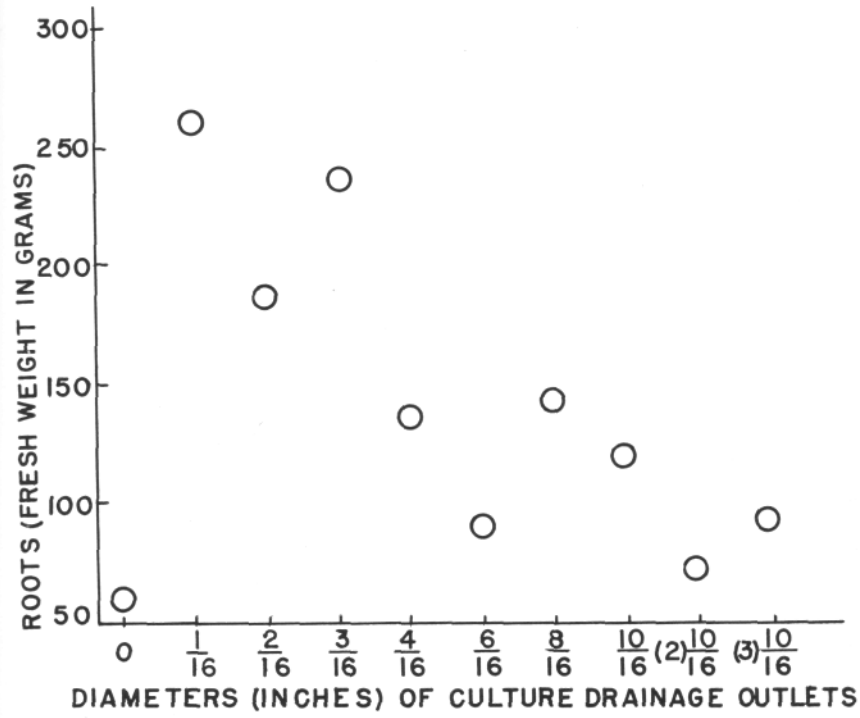

Fig. 4. *Effect of the rate of drainage upon the fresh weight of the roots of avocado seedlings. The fresh weights increased as the rate of drainage decreased except that where no drainage at all occurred the fresh weight of the roots was the lowest.*